

You have the full ninety minutes to complete this exam. Recall that partial credit will be given to partial work. Write neatly, and good luck.

1. Innovation in low-tech espionage (30 pts)

Two firms (General Electric and Sony) produce micro-cassette voice recorders. (Inverse) demand for these recorders is given by  $P = 100 - Q$ . GE has a proprietary technology that enables it to produce recorders as a constant marginal cost of \$10 each. Sony has an older technology that enables it to produce recorders at a constant marginal cost of \$16 each. Recorders produced by the two firms are homogeneous. Neither firm faces fixed costs.

A. Assume that the two firms compete in quantities.

- (i) What are the equilibrium quantities and profits for each firm? What is the market price?

This is the standard Cournot duopoly with heterogeneous costs. Given inverse demand of  $P = 100 - q^{GE} - q^{Sony}$ , marginal revenue for each firm will be  $MR_i = 100 - 2q_i - q_j$ . Setting this term equal to respective marginal cost and solving yields the following best-response functions:

$$q^{GE} = 45 - (1/2)q^{Sony}$$

$$q^{Sony} = 42 - (1/2)q^{GE}$$

Solving for the Nash equilibrium yields  $q^{GE} = 32$ ,  $q^{Sony} = 26$ ,  $Q = 58$ , and  $P = 42$ . Profits are  $\Pi^{GE} = (42-10)*32 = 1024$  and  $\Pi^{Sony} = (42-16)*26 = 676$ .

- (ii) Suppose Sony could develop a “copycat” technology with identical costs to GE. How much (if anything) should it be willing to spend in developing this technology?

If Sony is successful, it will face Cournot duopoly with identical costs. Now both firms face the best-response function of GE in the above case. The Nash equilibrium exists at  $q^{GE} = q^{Sony} = 30$ ,  $Q = 60$ , and  $P = 40$ . Profits are  $\Pi^{GE} = \Pi^{Sony} = (40-10)*30 = 900$ , so Sony would be willing to pay up to \$224 for this technology (this is its increase in profits).

- (iii) What is the social value of developing this technology given Cournot competition?  
(Hint: Add'l Value =  $\Delta\Sigma\pi + \Delta\text{Consumer Surplus}$ )

If Sony does not develop the copycat technology, industry profits are  $\Sigma\Pi = 1700$ . Consumer surplus is  $CS = \frac{1}{2}(58*58) = 1682$ , and total welfare is  $W = 3382$ . If Sony does develop the copycat technology, industry profits are  $\Sigma\Pi = 1800$ , consumer surplus is  $CS = \frac{1}{2}(60*60) = 1800$ , and total welfare is  $W = 3600$ . The value to society of Sony developing this technology (ignoring development costs) is  $\Delta W = 218$ .

B. Now assume that the two firms compete in prices

- (i) What are the equilibrium quantities and profits for each firm if GE uses its proprietary technology and Sony uses its old technology? What is the market price?

Under Bertrand competition, GE prices at (just under) \$16 and takes the whole market. Quantity sold is (just over) 84, profit is (just under) 504.

- (ii) Suppose Sony could develop a “copycat” technology with identical costs to GE. How much (if anything) should it be willing to spend in developing this technology?

Sony is not willing to pay anything to develop the new technology. If it has the new technology, price competition forces the price down to \$10 and neither firm earns profits. With nothing to gain, Sony has no reason to spend any money.

- (iii) What is the social value of developing this technology given Bertrand competition?  
(Hint: Add'l Value =  $\Delta\Sigma\pi + \Delta\text{Consumer Surplus}$ )

If Sony does not develop the copycat technology, industry profits are 504, and consumer surplus is  $CS = \frac{1}{2}(84*84) = 3528$ , so total welfare is 4032. If Sony does develop the technology, industry profits are zero and consumer surplus is  $CS = \frac{1}{2}(90*90) = 4050$  (which is also total welfare). The value to society of Sony developing this technology (ignoring development costs) is  $\Delta W = 18$ .

C. Given that both firms were originally using the public technology ( $MC=16$ ), both the social value and incentives for GE to develop its proprietary technology ( $MC=10$ ) are larger under Bertrand competition than under Cournot competition. (Take this as a fact, though you could derive the result if you had enough time.) How does this compare to your findings for the social value and Sony's incentives to develop the "copycat" technology? Provide a brief explanation of why the results are similar or different.

GE has a strong incentive to develop the new technology because it gives it a cost advantage over its competitor. In Bertrand competition, it allows GE to have the entire market and make a profit. In Cournot competition, it allows GE to produce more than Sony and earn higher profits. (Cournot competition where both firms have  $MC = 16$  results in each firm earning \$784 in profit, so the technology increased GE's profits by \$244.) Sony, on the other hand, is playing catch-up and does not have as strong of an incentive. Its development of the technology under Cournot competition was only worth \$224 because it's driving the market price down even more than GE's development of the technology did. And in Bertrand, either way Sony will not earn profit, so there is no reason whatsoever to develop the technology.

## 2. Another approach to advertising (20 points)

A. We might represent the demand for cigarettes by a differentiated product demand that depends upon both price and advertising. For example, suppose the demand for cigarettes produced by firm  $i$  when there are  $n$  firms is

$$Q_i^D = \left( g_0 + b \ln(A_i) - \beta \sum_{j \neq i} \ln(A_j) \right) * \left( g_1 - d \ln(P_i) + \delta \sum_{j \neq i} \ln(P_j) \right)$$

where  $P$  denotes price,  $A$  denotes advertising expenditures, and  $g_0$ ,  $b$ ,  $\beta$ ,  $g_1$ ,  $d$  and  $\delta$  are all non-negative parameters.

- (i) If  $b > 0$  and  $\beta = 0$ , describe (qualitatively and in economic terms) the effect that advertising has on this market.

Your own firm's advertising has an increasing effect on your demand, but it is decreasing. Other firms' advertising does not affect your sales, and your advertising does not affect other firms' sales. Advertising in this case works strictly to expand the market rather than stealing customers.

- (ii) If  $b > 0$  and  $\beta > 0$ , describe the effect that advertising has on this market. What effect would advertising have if  $b > 0$ ,  $\beta = b/(n-1)$  and firms are identical? (Hint: consider a symmetric equilibrium in advertising.)

Your own firm's advertising has an increasing effect on your demand, while other firms' advertising has a decreasing effect on your demand. Some customer-stealing is going on. Depending upon the magnitudes of the parameters, this stealing may be total with no market expansion. That is the case of the symmetric equilibrium in advertising given the particular value of  $\beta$  where your firm's advertising exactly offsets your rivals'.

(iii) Based on what you know about the cigarette industry, what do you think are the likely effects of firm-level advertising on demand for this market? Explain briefly. The demand for cigarettes overall is price-inelastic and probably not affected much by the total level of advertising in the industry. Firm-specific advertising is therefore probably going to have the effect of shifting demand from one firm to the other. We would expect a high level of advertising in this industry, since that seems to be the only way to increase your own demand.

B. In November 1998, the major tobacco companies settled multi-state litigation with an agreement to pay nearly \$250 billion to the states over the next 25 years as compensation for smoking-related health care costs. They also agreed to abide by significant restrictions on the nature of cigarette marketing and promotional activity. While this settlement was being negotiated but before it was signed, firms engaged in intense price competition as well as extensive advertising and marketing activity. Briefly sketch an economic rationale for this behavior.

Given the scenario described above in 2Aiii, we expect that the only way to increase your demand is to advertise and steal customers away from other firms. Once this settlement goes into effect, firms are not going to be able to do this. As such, firms stepped up their advertising activity before the settlement went into effect, hoping to steal as many customers as possible before they are forced to reduce their advertising.

### 3. Predatory pricing (10 pts)

The short-run marginal cost of adding a passenger to an already-scheduled flight is probably less than \$15. Because American charged more than this during price wars with new entrants in the Dallas-Ft. Worth market, it cannot have engaged in predatory pricing. True, False, or Uncertain? Provide an explanation.

FALSE. Predatory practices are generally defined as practices that are only justifiable because they deter entry or force other firms to leave. From our prior homework, Homer's purchase of the Super-Plow was predatory because, if he were ignoring potential entry, he would not have purchased it. But Homer still earned positive profits, even with the Super-Plow. In this case, the standard is whether low AA prices only made economic sense if they drove new entrants from the market. Whether the prices were below marginal cost is irrelevant.

### 4. Empirics in the real world (10 pts)

We discussed a number of techniques that economists use to identify industries and sectors with market power when marginal cost data are unavailable. Name and discuss two of these techniques. Use actual empirical applications to illustrate your choices.

#### 1. Estimating residual demand: domestic beer brewing (Baker & Bresnahan)

This technique solves for best response functions and substitutes them into a firm's inverse demand (price expression). The question is then whether a firm's own-quantity decision has an impact upon its price in equilibrium (i.e., after all the rivals have responded). A firm with no market power has a flat residual demand curve, while a firm with market power will have a residual demand curve with negative slope.

2. Directly estimating market power distortion:  $L = (P - MC)/P$ , % of price that cannot be explained by cost: domestic sugar production in early 20<sup>th</sup> century (Genesove & Mullin)

This technique estimates demand and finds the marginal revenues that would have arisen at observed price/quantity decisions. Given the profit-maximization assumption, this allows the inference of marginal costs which can then be combined with prices in the Lerner index.

3. Identifying price wars: 19<sup>th</sup> century railroad shipping (Porter)

If systematic price variation can be conclusively attributed to strategic behavior rather than cost shocks, then there must exist a collusive arrangement. And if there's collusion, there's market power.

4. Identifying price discrimination: contemporary retail gasoline (Shepard)

If systematic price variation can be conclusively attributed to strategic behavior rather than cost shocks, then that's price discrimination. And if there's price discrimination, there's market power.

5. The merger that would scare Microsoft most (30 pts)

Imagine that Dell and Intel are monopolists in their own markets. Dell produces laptop computers, each of which is produced by combining exactly one computer chip and a fixed bundle of other inputs in fixed proportions. Intel is the only supplier of these computer chips. Prices are in dollars, while quantities are in millions. The box below summarizes their profits (payoffs) under alternative pricing choices:

		Dell	
		$p^{\text{Laptop}} = 800$	$p^{\text{Laptop}} = 900$
Intel	$p^{\text{Chip}} = 500$	0, 2000	0, 1500
	$p^{\text{Chip}} = 700$	2000, 0	1000, 500

A. What are the Nash equilibrium prices? Explain your reasoning.

The Nash equilibrium is for chip prices to be 700 and laptop prices to be 900. This is the Nash equilibrium because each decision is a best-response to the other player's decision. Intel has a dominant strategy to charge a price of 700, since its profits are higher doing this regardless of Dell's decision. Given this, Dell is choosing between profits of 0 and profits of 500, so it chooses 500. Given this choice, neither party wants to deviate, so it is a Nash equilibrium.

Suppose that the (inverse) demand for laptops ( $Q^{\text{Laptop}}$ ) is given by  $P = 1000 - 20 \cdot Q^{\text{Laptop}}$ .

B. At the Nash equilibrium of part (A), how many laptops are being sold?

$P = 1000 - 20 Q^{\text{Laptop}}$ , and we know from (A) that  $P = 900$ . Therefore,  $Q^{\text{Laptop}} = 5$ .

Suppose that Dell's marginal costs are constant and equal to the price it pays Intel for a chip plus a constant \$100 per laptop. Further suppose that Intel's marginal costs are constant and that both firms have zero fixed costs.

C. What are Dell's marginal costs in equilibrium?

Dell's MC = 700 for the chip and 100 for other expenses per unit, or 800.

D. If the firms merged, what prices would they set and what profits would the merged firm earn?

In equilibrium, we know that  $P^{\text{Chip}} = 700$  and 5 chips are sold. We also know that Intel has no fixed costs, and its MC is constant. Profits for Intel in equilibrium are 1000, implying a profit of 200 per unit. This means that Intel's MC must be 500. Thus, the total MC of production is Intel's MC plus Dell's MC, which is  $500 + 100 = 600$ .

$P = 1000 - 20Q$ , so  $MR = 1000 - 40Q$ . Setting  $MR = 600$  implies  $Q = 10$ .  $P = 1000 - 200 = 800$ . Profits =  $(800-600)*10 = 2000$ . This contrasts with the combined profits of 1500 for the separate firms, so a merger would be profitable.

E. Should antitrust authorities oppose such a merger? Why or why not? Be specific and use the data in this problem.

Antitrust authorities should not oppose a merger in this situation. In the initial scenario, the market suffers from double marginalization, where the final price of a computer is essentially marked-up twice: once for the computer chip and a second time for the laptop. Merging the firms internalizes both of these mark-ups and the result is that prices fall and output increases. Despite the fact that profits of the merged firm rise, consumer surplus actually increases as a result of the merger, going from 250 to 1000.